

Feasibility Study of Resource Recovery
Opportunities for Macon/Bibb and
Houston Counties Georgia - Volume 1

CSI Resource Systems, Inc.
Boston, MA

Prepared for

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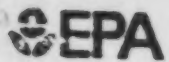
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Solid Waste



A TECHNICAL ASSISTANCE PROGRAM REPORT

**FEASIBILITY STUDY OF
RESOURCE RECOVERY
OPPORTUNITIES FOR
MACON / BIBB AND
HOUSTON COUNTIES,
GEORGIA**

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Technical assistance by personnel teams. 42 USC 6913

RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

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PRELIMINARY FEASIBILITY STUDY
OF RESOURCE RECOVERY OPPORTUNITIES
FOR MACON/BIBB AND HOUSTON COUNTIES, GEORGIA

VOLUME 1

PREPARED FOR
OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV, ATLANTA, GEORGIA

BY

CSI RESOURCE SYSTEMS, INC.
BOSTON, MASSACHUSETTS

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VOLUME 1

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PREFACE

This report was prepared for the city of Macon/Bibb County and Houston County, Georgia, under the Technical Assistance and Panels Program, which is conducted by the U.S. Environmental Protection Agency (EPA) to provide assistance to state and local governments. Technical assistance was provided in response to requests submitted to U.S. EPA Region IV by the city of Macon/Bibb County and Houston County.

The report presents the results of a preliminary determination of the feasibility of resource recovery for the two counties. This determination involved development of first-order estimates of the quantity of waste generated by Macon/Bibb and Houston counties; evaluation of the market potential for energy recovery; development and evaluation of resource recovery alternatives; and identification of the major tasks to be performed prior to deciding to implement a resource recovery project. These activities reflect the results of several site visits to Macon/Bibb and Houston counties by CSI Resource Systems, Inc., and interviews with personnel from the two counties; various municipalities located in the two counties; and 12 industrial energy users in the area.

Resource Systems is a technical assistance contractor to the Office of Solid and Hazardous Waste, U.S. EPA Region IV. Under the terms of the Technical Assistance and Panels Program, all of Resource Systems' technical assistance activities on behalf of Macon/Bibb and Houston counties were paid for by EPA.

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CHAPTER 1. OVERVIEW

The middle Georgia area expects to face solid waste management problems in the next 5 to 10 years, because the capacities of landfills in the area are limited and waste disposal costs are rising. Particular concern has been expressed by Bibb County; its principal city, Macon; and adjacent Houston County. The Bibb County landfill was recently closed; the estimated remaining life of the Macon city landfill is less than 7 years; and that of the Houston County landfill is 2.5 to 5 years. In 1979, in response to these problems, preliminary studies were undertaken to determine whether resource recovery could realistically be considered as an alternative approach to solid waste management in the area.

In June 1979, a study by the Macon-Bibb County Planning and Zoning Commission indicated that resource recovery may be effective in keeping future disposal costs down and in extending the life of the Macon landfill and other landfills that might be established in Bibb County.¹ Because the results of this broad, preliminary study were encouraging, the city of Macon/Bibb County requested technical assistance from the U.S. Environmental Protection Agency (EPA), under its Technical Assistance and Panels Program. The purpose of this assistance was to evaluate the findings of the commission's report and to identify specific, feasible resource recovery alternatives.

In August 1979, a study of Houston County by the Middle Georgia Area Planning and Development Commission (APDC) concluded that materials recovery offers the greatest potential for immediate implementation and that energy recovery should be evaluated further.² After additional investigation and analysis, Robins Air Force Base (RAFB) was identified as a potential customer for steam recovered from the waste generated in Houston County and, possibly, in Macon/Bibb County as well. RAFB, a

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1. Macon-Bibb County Planning and Zoning Commission, Macon/Bibb/County/ Middle Georgia Resource Recovery Study, June 1979.
 2. Middle Georgia Area Planning and Development Commission, Houston County/ Middle Georgia Resource Recovery Feasibility Study, August 1979.

major Department of Defense installation located adjacent to Warner Robins, Georgia, about 19 miles southeast of Macon, was interested in the possibility of purchasing waste-derived energy from a resource recovery facility. To investigate this possibility, Houston County also requested technical assistance from EPA.

Underlying their interest in determining the feasibility of energy recovery is the two counties' recognition that solid waste is a valuable alternative energy resource. Macon/Bibb and Houston counties together generate an estimated 150,000 tons of solid waste annually. Typical higher heating value (HHV) estimates of 4,500 British thermal units (Btu) per pound suggest that a ton of solid waste has an energy value equivalent to nearly 62 gallons, or 1.4 barrels, of oil. Thus, the solid waste currently discarded by the two counties each year has an energy equivalent of nearly 210,000 barrels of oil. Rapid increases in energy prices have provided an additional impetus to recovering this energy from solid waste. In addition, by reducing substantially the volume of material to be landfilled, resource recovery can extend the useful lives of existing landfills.

The feasibility of resource recovery in the two counties depends upon the presence of five basic ingredients:

- Potentially viable energy buyers whose requirements would use all of most of the usable, or processible, solid waste generated.*
- A sufficient tonnage of processible solid waste from which enough energy and/or salable materials could be produced to meet the requirements of one or more potentially viable buyers.
- Potentially available sites that are well situated with respect to the shipment of solid waste and the delivery of energy to prospective buyers.

* Processible solid waste is that tonnage of the total waste potentially available which could be processed in a resource recovery facility. Unprocessable materials include oversized bulky waste (e.g., large metal objects, bed springs, rugs) and white goods.

- Resource recovery technologies that can reliably process available solid waste and produce energy and/or salable materials in the form, quality, and quantity required by prospective buyers.
- A total disposal cost that is competitive with the costs of alternative disposal methods available to participating communities.

To assist the two counties in establishing the feasibility of resource recovery, the solid waste disposal problems faced by the two counties were assessed, including an examination of current waste collection and disposal practices, the quantity of waste generated, and current and projected landfill costs. Next, specific resource recovery alternatives were defined by identifying potential customers for recovered energy and technologies that are compatible with both the customers' energy needs and the available waste. These alternatives include projects that the counties could pursue separately, as well as the joint project with RAFB. Finally, the alternatives were evaluated, focusing on their total annual disposal costs as compared with the cost of continued landfilling. Projects that appear to be feasible, and the steps to be taken before implementing these projects, were identified.

In the remainder of this chapter, the study findings/conclusions are presented, and the immediate next steps to be taken by the counties are noted, along with general issues of importance to project implementation.

STUDY FINDINGS/CONCLUSIONS

The findings of this preliminary feasibility study indicate that several resource recovery alternatives are feasible for Macon/Bibb and Houston counties, and the two counties should give serious consideration to in-depth exploration of one or more of these projects. This conclusion is based upon the following study findings:

- The city of Macon/Bibb County and Houston County face solid waste disposal problems because:
 - With annual waste generation estimates of 95,900 and 54,600 tons, respectively, Macon/Bibb and Houston counties will need new waste disposal capacity in the near future.

- Siting new landfill capacity is becoming increasingly difficult because of citizen opposition.
- Total annual disposal costs for landfilling are projected to increase: in Macon/Bibb, from the 1979 level of \$320,000 to an estimated \$884,800 in 1988; in Houston, from the 1979 level of \$290,800 to an estimated \$659,200 in 1988.
- Macon/Bibb and Houston counties appear to have available sufficient processible waste to support their own resource recovery projects; waste generation in Bibb County outside Macon does not appear sufficient to support a resource recovery facility.
- There are several potential buyers of low-pressure process steam or high-temperature gas in Macon-Bibb and Houston counties.
- The joint project with RAFB appears feasible. This project would consist of a mass-burning waterwall (MBWW) system with a design capacity of 420 tons per day (TPD) and a throughput capacity of 335 TPD₇.^{*} The MBWW would convert the waste generated by Macon/Bibb and Houston counties to low-pressure process steam for sale to RAFB. Depending upon the financing method used, this alternative would offer the two counties estimated total annual disposal costs of \$1,978,000 to \$2,156,000 in 1983, and \$1,566,000 to \$1,745,000 in 1988.
- For Houston County alone, the most attractive resource recovery opportunity is a modular combustion unit (MCU) system with a design capacity of 200 TPD and a throughput capacity of 168 TPD₅. The MCU system would convert waste generated in Houston County to low-pressure process steam for sale to RAFB. Depending upon the financing method used, this alternative would offer the county estimated total annual disposal costs of \$510,000 to \$621,000 in 1983, and \$314,000 to \$425,000 in 1988.

* Design capacity is the manufacturer's rated capacity of the waste processing equipment. Annual average throughput is the amount of waste processed by the system on a TPD₅ (5-day-per-week) or TPD₇ (7-day-per-week) basis (depending on the system definition) averaged throughout the year.

- For Macon/Bibb County alone, two resource recovery opportunities appear feasible:
 - An MCU system with a design capacity of 330 TPD and a throughput capacity of 295 TPD₅, to convert waste generated in Macon and Bibb County into low-pressure process steam for sale to B&W, Texprint, and YKK. If 25-percent equity financing can be obtained, total annual disposal costs are projected to be around \$958,000 in 1983 and \$786,000 in 1988.
 - An MCU system with a design capacity of 330 TPD and a throughput capacity of 295 TPD₅, producing high-temperature gas for sale to Armstrong Cork Company. Depending upon the financing method used, estimated total annual disposal costs range from \$142,000 to \$564,000 in 1983, and, in 1988, from a cost of \$101,000 to a profit of \$321,000.
- These resource recovery projects compare favorably with continued primary reliance on landfilling in several respects:
 - Resource recovery offers decreasing waste disposal costs, which could be competitive with the cost of landfilling by 1988.
 - A cost-competitive and secure alternative source of energy is provided for energy customers.
 - Additional jobs are created in the two counties.
 - The remaining useful lives of the city of Macon and Houston County landfills are extended.
 - Resource recovery is an environmentally sound disposal practice, which could eliminate the need to find a new site for the Bibb County landfill.

NEXT STEPS

The findings outlined above are preliminary indications of project feasibility; further investigation is necessary to determine whether these projects can or should be implemented. Specifically, three major tasks must be performed to verify the preliminary findings, before committing substantial resources to implement a resource recovery project. These next

steps are:

1. Ascertain the level of interest of prospective energy customers. Perform more detailed evaluations of their energy practices and requirements, including detailed energy load profiles with hourly, daily, and seasonal variations; aggregate current and projected fuel costs; and electrical, water, and other utility charges.
2. Establish a weighing program in the city of Macon and the remainder of Bibb County to ascertain that sufficient solid waste is available, and perform an analysis of waste composition in both counties to ascertain that the waste has a sufficient energy value to satisfy the requirements of potential energy buyers. In addition, determine the seasonal fluctuations in waste quantity and composition.
3. Determine who controls the various portions of the waste stream and develop strategies to ensure that waste generated in Macon/Bibb and Houston counties can be directed to a resource recovery facility.

If these three tasks confirm the potential feasibility of the projects identified, a detailed feasibility study should be performed. Such a study will enable Macon/Bibb and Houston counties to decide whether to proceed toward resolving project implementation issues, including system performance requirements, risk management, procurement, and financing.

Macon/Bibb and Houston counties should also be aware that:

- More than 20 percent of the waste stream will require ultimate landfill disposal, even if resource recovery is implemented. This waste includes oversized, bulky materials and noncombustibles, which are diverted from the project, and residues of combustion. The cost of this landfilling has been taken into account in developing the economic projections.
- The lead time for a resource recovery project is significant. For example, implementation of an MCB system requires a minimum of 24 months after procurement contracts are executed. This lead time suggests mid-1983 as the earliest date for a fully operational system.

- Until recently, industry viewed recovered energy as lower in quality and less reliable than other types of energy, and expected the price of the recovered energy to be lower. This expectation is beginning to change, as industrial concerns recognize that resource recovery offers them energy self-sufficiency.

In the remainder of this report, the results of the preliminary feasibility study are presented. In Chapter 2, current waste collection and disposal practices are described; the quantity of solid waste generated in the two counties is estimated; and the costs of continued landfilling are projected. In Chapter 3, specific resource recovery alternatives are defined on the basis of potential energy markets identified and technologies selected as appropriate. In Chapter 4, these alternatives are evaluated in terms of their economic competitiveness with landfilling and their overall advantages and disadvantages. In Chapter 5, the next steps to be taken are described, and more general implementation issues are briefly reviewed. Appendixes to the report, which are contained in Volume 2, provide more detailed data in support of the study findings and conclusions.

CHAPTER 2. SOLID WASTE COLLECTION, DISPOSAL, AND GENERATION

The attractiveness of resource recovery for the city of Macon/Bibb County and Houston County depends in part on the extent to which the two counties face solid waste disposal problems, and on the economics of resource recovery as compared with alternative waste disposal methods (i.e., continued primary reliance on land-filling). To identify waste supply disposal problems, current solid waste collection and disposal practices were reviewed, and preliminary estimates of waste generation were developed. Current waste disposal costs were then determined, and the costs of continued landfilling were projected for the years 1983 and 1988. A comparison of waste generation and the estimated lives of existing landfills indicates that Macon/Bibb and Houston counties face solid waste disposal problems in the near future. The counties will need additional disposal capacity, and new landfills will likely be difficult to site. Moreover, as cost projections indicate, landfill disposal costs are expected to escalate rapidly.

In this chapter, current solid waste collection and disposal practices in the two counties are described; waste generation is estimated; and the future costs of landfilling are projected.

CURRENT COLLECTION AND DISPOSAL PRACTICES

To assess solid waste disposal problems, current solid waste collection and disposal practices in Macon/Bibb and Houston counties were examined. In both these areas, waste is collected predominantly by municipalities and the counties themselves. Most waste is disposed of in landfills having limited capacities. Bibb County is now facing major waste disposal problems, and the city of Macon and Houston County can anticipate such problems within the next 5 to 10 years.

City of Macon/Bibb County

In the city of Macon, the majority of waste is collected and disposed of by the city. The Macon Department of Public Works collects residential waste through a municipal collection system and disposes of the waste in a landfill owned and operated by the city. This landfill operates 6 days per week and accepts waste without charge from its own packer trucks and from Macon residents using private vehicles. Private haulers pay a tip fee based on estimated cubic yardage of waste. In fiscal year 1979, an estimated 77,000 tons of waste were disposed of at the Macon city landfill.* The estimated remaining life of this landfill is approximately 7 years. The city is, however, considering the purchase of 36 acres of land adjacent to the landfill. If this additional acreage is purchased, the life expectancy of the landfill should be lengthened.

The city attempts to reduce the amount of waste requiring disposal at the landfill. In its newspaper recycling program, the city encourages citizens to deliver their bundled newspapers to boxes located throughout Macon. The city does not currently recycle corrugated materials, but it is believed that the extensive use of recycled corrugated by the Georgia Kraft facility in Macon (as much as 425 TPD⁷) reduces significantly the quantity of corrugated material that would otherwise be delivered to the city landfill.

In the areas of Bibb County outside Macon, the county is responsible for the majority of waste collection and disposal. The Bibb County Sanitation Department provides waste collection service to county households outside Macon. Until this year, Bibb County owned and operated a landfill at the Lewis Wilson Airport. In 1979, an estimated 19,000 tons of waste were disposed of at the Bibb County landfill. Early in 1980, the Federal Aviation Administration recommended that the Bibb County landfill be closed, because it attracts birds that are a potential hazard to aircraft during landing and takeoff. As a result, the landfill was closed,

* This estimate is based on a per-capita waste generation rate of 3.3 pounds per person per day, as established by a weighing program conducted at the Houston County landfill. On the basis of visual inspection of arriving trucks, local officials estimate that 92,500 to 108,000 tons of waste were disposed of at the Macon city landfill in 1979.

and the waste diverted to the Macon city landfill, under a 6-month agreement with the city of Macon. Within 6 months, Bibb County will have to find an alternative landfill. The county's recent attempts to secure a new landfill site have met with considerable public opposition, and such opposition is expected to make siting of a new landfill difficult.

Houston County

In Houston County, various county and municipal agencies are responsible for solid waste collection and disposal. Most of the county's waste is collected by several municipalities. In the city of Warner Robins, the City Sanitation Department collects residential waste; commercial and industrial wastes are collected by private contractors. In Centerville, residential waste is collected by a private contractor. In the city of Perry, residential and commercial waste is collected by the Perry Department of Public Works. Most of Perry's industrial waste is collected by the Kellwood Company, a private contractor.

Houston County's waste is disposed of at the Houston County landfill and the Perry landfill, the only licensed disposal facilities in the county. The Houston County landfill is located on a site owned by the Medusa Portland Cement Company and leased to the county for a nominal fee. This lease runs until 1990, but the remaining life of the landfill is estimated to be only 2.5 to 5 years. In 1979, nearly 55,000 tons of waste were delivered to this landfill. There is no charge to private vehicles or to municipal or county collection vehicles. Commercial haulers are charged a tip fee of \$3.50 per ton. The Perry landfill, which is owned and operated by the city of Perry, is much smaller than the county landfill. It is estimated that 8,500 tons of solid waste were delivered to this landfill in 1978; however, detailed data on the Perry landfill are not available, and actual tonnage might be considerably lower.

To maximize the remaining life of its landfills, Houston County has recently begun to recover corrugated materials and white goods. The county recovers waste corrugated from the Pabst Brewery, Midland Paper, and Continental Container, and sells the baled corrugated to Macon Recycling. White goods (e.g., refrigerators, stoves) are stockpiled at

the landfill and sold for a nominal fee to the LOEF Company in Athens, Georgia.

WASTE GENERATION

The quantity of waste generated in the city of Macon/Bibb County and Houston County appears adequate to support a resource recovery facility. Estimated waste generation in the two counties is shown below:

<u>County</u>	<u>Estimated 1980 Waste Generation (tons/year)</u>
Macon/Bibb	95,900
Houston	<u>54,600</u>
TOTAL	150,500

These estimates are based on a comprehensive weighing program conducted at the Houston County landfill in 1979. During that year, 54,688 tons of solid waste were delivered to the landfill. Using county population estimates presented in the Middle Georgia APDC's 1979 study,¹ per-capita waste generation was conservatively estimated as 3.3 pounds per day on a 7-day-per-week basis (2.01 pounds per day of residential waste and 1.32 pounds per day of commercial and industrial waste). These per-capita waste generation rates were applied to 1980 population projections (90,000 for Houston County and 158,000 for city of Macon/Bibb County) to estimate the amount of solid waste generated in each of the two counties. Additional study is needed to refine the estimate of waste generation in Macon/Bibb County, which has not yet conducted a weighing program.

The above estimates of the quantity of waste generated do not reflect seasonal variations in waste generation; nor do they provide for increases in future waste generation as a result of increased per-capita generation rates or population growth. Generation rates are not likely to increase significantly. For the purposes of this feasibility study, seasonal variations and population growth have not been considered; however, if a

1. Middle Georgia APDC, Houston County/Middle Georgia Resource Recovery Study, August 1979.

resource recovery project were to be implemented, the impact of these two factors on waste generation would need to be assessed.

CURRENT AND PROJECTED LANDFILL COSTS

As a basis for determining the economic feasibility of resource recovery, current landfill costs for Macon/Bibb and Houston Counties were examined, and 1983 and 1988 landfill costs were projected, assuming that a resource recovery project would not be implemented. These projections take into account site acquisition and development costs and the cost of operating a landfill that meets the minimum standards proposed by EPA under the Resource Conservation and Recovery Act (RCRA).

In Macon/Bibb County, operating costs were \$296,000 for the Macon city landfill in 1979, and \$22,400 for the Bibb County landfill in 1978. If Macon/Bibb County continued to rely on landfilling as a disposal method, the city of Macon could operate the city landfill until its projected exhaustion in 1987 and would then have to acquire, develop, and operate a new landfill. Bibb County would need to secure a new landfill immediately or arrange to transport its waste to an existing landfill (i.e., the city of Macon or the Houston County landfill). Assuming that waste generation will remain constant at 95,900 tons per year, landfill costs are projected to be \$658,600 in 1983, and \$884,800 in 1988. (See Appendix A for the derivation of landfill cost estimates.)

In Houston County, operating costs for the Houston County landfill were \$290,800 in 1979. (Cost data for the Perry landfill are not available.) If Houston County continued to dispose of its waste in landfills, the county landfill could be used until 1983 or 1985; the county would then have to acquire, develop, and operate a new landfill. Assuming that waste generation will remain constant at 54,600 tons per year, landfill costs are estimated to be \$471,500 in 1983, and \$659,200 in 1988.

CHAPTER 3. RESOURCE RECOVERY ALTERNATIVES

To investigate the potential role of resource recovery in solid waste management for Macon/Bibb and Houston Counties, an energy market survey was conducted and eight technically feasible resource recovery alternatives were identified. Each of these alternatives is based on a proven resource recovery technology that can use the available waste supply to produce usable energy in a form and quantity that fit the needs of potential energy buyers.

The estimate of the quantity of waste available to a resource recovery facility is based on estimated current waste generation. It was assumed, in the absence of a waste sampling program, that recovered materials (e.g., corrugated, white goods) and unprocessable waste amount to 20 percent of total waste generation. The remaining 80 percent of waste is assumed to be processible, on the basis of visual inspection of waste by local officials and previous experience. The resulting estimates of available waste supply are shown in the following table:

<u>County</u>	<u>Estimated Processible Waste Available</u>		
	<u>TPD₅</u>	<u>TPD₇</u>	<u>Tons per Year</u>
Macon/Bibb	295	211	76,700
Houston	168	120	43,680
TOTAL	463	331	120,380

Given these estimates of available waste supply, technically feasible resource recovery alternatives for the two counties were defined by:

- Identifying potential markets for the energy that could be produced from the available waste.
- Selecting resource recovery technologies that are compatible with the requirements of the markets and the characteristics of the available waste.

POTENTIAL ENERGY MARKETS

A brief survey of more than 80 potential customers focused on the size and variability of their energy demand; their ability to use recovered energy; their interest in resource recovery; and the availability

of an appropriate nearby site. As a result of this initial survey, the following 12 potential energy customers were identified: Armstrong Cork Company, B&W, Burns Brick Company, Cagle Poultry, Cherokee Brick and Tile Company, Georgia Kraft Company, Procter & Gamble, Texprint, and YKK (for Macon/Bibb County); Medusa Portland Cement Company and Pabst Brewing Company (for Houston County); and RAFB (for Houston County or Macon/Bibb and Houston counties). Representatives of these potential customers were interviewed about their current energy use and interest in resource recovery. The results of these interviews are presented in Appendix B.

Five of the 12 concerns interviewed warrant serious consideration as potential customers:

1. RAFB, adjacent to Warner Robins, which requires low-pressure steam and, possibly, electricity.
2. B&W, in Macon, which requires low-pressure steam.
3. Texprint, in Macon, which requires low-pressure steam.
4. YKK, in Macon, which requires low-pressure steam.
5. Armstrong Cork Company, in Macon, which requires high-temperature gas.

The requirements of these five customers are summarized in Table 1. Because of their small size, Texprint and YKK can be considered potential energy customers only in combination with B&W. Hence, these five energy customers constitute three potential markets: RAFB; B&W, Texprint, and YKK; and Armstrong Cork.

The five potential customers identified share the characteristics described in the following subsections.

Interest in Resource Recovery. Although interest cannot be viewed as a commitment, it was considered a prerequisite for a potential customer. Medusa Portland Cement was eliminated from consideration because of its lack of interest in resource recovery.

Technical Capability to Use Recovered Energy. Each of the five potential customers currently uses low-pressure steam or high-temperature gas, either of which can be recovered from solid waste, for process

TABLE 1
POTENTIAL ENERGY MARKETS

POTENTIAL ENERGY MARKET	ENERGY REQUIREMENT		FUEL DISPLACED
	Form	Quantity per Hour	
RAFB, Warner Robins	Steam	160,000 lb winter 45,000 lb summer	Natural gas
B&W, Macon	Steam	40,000 lb	Coal
Texprint, Macon	Steam	17,000 lb	Natural gas
YKK, Macon	Steam	15,000 lb	Natural gas
Armstrong Cork, Macon	High- temperature gas	300 million Btu	Natural gas

requirements and/or heating and cooling. Average hourly energy loads are high, seasonal variations in energy use appear to be acceptably low, and there are no unusual pressure or temperature requirements.

Cherokee Brick and Tile and Procter & Gamble were eliminated from consideration because of technical uncertainties. Cagle Poultry was eliminated because its energy demand is too small, except when combined with that of Procter & Gamble. Burns Brick was not considered further because of its small energy demand.

Continuity of Operations. Each of the five potential customers operates three shifts, 5, 6, or 7 days per week, indicating potentially high capacity utilization.

Current Use of High-cost Fuel. Four of the five potential customers currently use natural gas, a high-cost fuel. In these four markets, recovered energy would displace steam or high-temperature gas, generated from natural gas at a cost of \$3.30 to \$5.00 per million Btu. From previous experience, \$2.30 per million Btu was considered the minimum current steam cost that would make resource recovery economically feasible. However, B&W, which generates steam from coal at a cost less than \$2.30 per million Btu, was considered further, because (1) a facility serving B&W could also serve Texprint and YKK and, thus, could displace higher-cost natural gas as well as coal; and (2) B&W might be willing to make an equity investment in a resource recovery facility, thereby reducing the capital cost of the facility to Macon/Bibb County.

Georgia Kraft Company was eliminated from further consideration because it currently uses coal and waste wood, two low-cost fuels. However, if, upon further investigation, the other potential customers in Macon/Bibb County do not prove to be good prospects for resource recovery, Georgia Kraft should be reconsidered as a potential energy customer.

Proximity to a Suitable Site. For each of the potential markets, at least one vacant site of adequate size is potentially available close enough to the potential customer to enable economic transportation of steam or high-temperature gas.

Proximity to Waste Source. Each potential market is close enough to a source of waste so that waste transfer operations are not necessary assuming single-county projects. In the event that Macon/Bibb and Houston counties implemented a joint project at RAFB, a transfer operation would be necessary to transport waste from Macon; however, other projects at RAFB would not require transfer operations.

Pabst Brewing Company, an otherwise attractive potential market in Houston County, was eliminated from consideration because its distance from major waste sources would necessitate transfer operations. However, if, upon further investigation, the other potential customer in Houston County (i.e., RAFB) does not prove to be a good prospect for resource recovery, Pabst should be reconsidered as a potential energy customer.

Stability. Each potential energy customer has been operating in the area for at least several years and appears to be in sufficient financial health to justify consideration as a long-term energy buyer.

TECHNICALLY FEASIBLE ALTERNATIVES

The estimated quantity of combustible solid waste available and the energy requirements of prospective customers dictate both the scale of a resource recovery facility and the form of energy produced. To identify resource recovery alternatives, the energy requirements of the five potential energy customers were compared with the technical characteristics of compatible, demonstrated technologies. As a result, the following eight resource recovery alternatives were defined:

1. A 335-TPD₇ (throughput) MBWW system providing steam to RAFB
2. A 335-TPD₇ (throughput) MBWW system providing steam and electricity to RAFB
3. A 168-TPD₅ (throughput) MCU system providing steam to RAFB
4. A 295-TPD₅ (throughput) MBWW system providing steam to B&W

5. A 295 TPD₅ (throughput) MBWW system providing steam to B&W, Texprint, and YKK
6. A 295-TPD₅ (throughput) MCU system providing steam to B&W
7. A 295-TPD₅ (throughput) MCU system providing steam to B&W, Texprint, and YKK
8. A 295-TPD₅ (throughput) MCU system providing hot gas to Armstrong Cork.

The characteristics of these alternatives are summarized in Table 2.

In developing the eight alternatives, the following three generic resource recovery technologies were considered. Each of these technologies has been demonstrated commercially or is in the process of startup and thus has reasonably established operating parameters.

1. An MBWW system to produce steam or to cogenerate steam and electricity. The production of electricity alone was not considered, because of the institutional and legal difficulties of retailing electricity and because the electricity would have to compete with the abundant and low-priced electricity produced by Georgia Power Company. MBWW systems that produce steam are now operating in several cities, including Nashville, Tennessee; Saugus, Massachusetts; and Norfolk, Virginia.

2. A dedicated boiler system, in which coarsely shredded solid waste is burned to produce steam. With this system, solid waste is shredded to 4-inch particles. Before shredding, oversized, bulky materials and other unprocessibles are extracted, and, after shredding, the pulverized waste is run under a magnet to recover magnetic materials for sale to scrap markets. The coarsely shredded solid waste is then fired in a specially designed boiler to produce steam. One dedicated boiler system is operating in Hamilton, Ontario, and another is in the process of startup in Akron, Ohio.

3. An MCU system to produce low-pressure steam or high-temperature gas. This small-scale, modular system can range in design capacity from less than 100 TPD to 350 TPD and can produce 10,000 to 50,000 pounds of low-pressure steam per hour. MCU systems are operating in a number of cities, including North Little Rock, Arkansas, and Salem, Virginia.

TABLE 2
RESOURCE RECOVERY ALTERNATIVES

ALTERNATIVE	WASTE SOURCE	ENERGY MARKET	SYSTEM CONFIGURATION	SYSTEM CAPACITY			ENERGY PRODUCT	
				Throughput TPD	Days/ Week	Design Capacity TPD	Form	Quantity/hour
1	Macon/Bibb and Houston	RAFB	One 420-TPD MBWW	335	7	420	Steam	71,000 lb
2	Macon/Bibb and Houston	RAFB	One 420-TPD MBWW	335	7	420	Steam Electricity	69,000 lb 3,700 kW
3	Houston	RAFB	Four 50-TPD MCUs	168	5	200	Steam	34,000 lb
4	Macon/Bibb	B&W	One 330-TPD MBWW	295	5	330	Steam	69,000 lb
5	Macon/Bibb	B&W, Tex-print, YKK	One 330-TPD MBWW	295	5	330	Steam	69,000 lb
6	Macon/Bibb	B&W	Six 55-TPD MCUs	295	5	330	Steam	60,000 lb
7	Macon/Bibb	B&W, Tex-print, YKK	Six 55-TPD MCUs	295	5	330	Steam	60,000 lb
8	Macon/Bibb	Armstrong	Six 55-TPD MCUs	295	5	330	High-temperature gas	90 million Btu

On the basis of in-depth engineering estimates recently performed for the cities of New York and St. Louis, the capital and operation and maintenance (O&M) costs of comparably sized MBWW and dedicated boiler technologies are likely to be similar. Thus, for the purpose of this analysis, the two technologies are considered interchangeable, both technologically and economically. The MBWW system has been used in this analysis as being representative of both systems. The ultimate choice between the MBWW and dedicated boiler technologies can be made only after evaluating detailed customer and site-specific information.

The following subsections describe the resource recovery alternatives developed to serve the three primary markets identified (i.e., RAFB; B&W, Texprint, and YKK; Armstrong Cork).

RAFB

RAFB has a continuous steam demand that could be supplied by several system types and configurations. The base's summer demand for 125-psig steam does not drop below 225,000 pounds per hour on weekdays (40,000 pounds per hour on weekends). A facility to produce this quantity of steam could easily use all of the waste from both Macon/Bibb and Houston counties. Moreover, sites are available for a resource recovery plant less than 1 mile from RAFB's existing power plant. Three alternative system configurations were selected for RAFB.

The first alternative (alternative 1) would use the waste streams from both counties to supply steam to RAFB. A transfer station would be installed in Macon, from which tractor-trailer trucks could haul Macon/Bibb's waste to the base. A single-unit MBWW energy recovery plant, located on the base, would produce 125-psig steam, which would be piped into the power plant or the base's steam distribution system. The plant would operate 7 days per week, with a throughput averaging 335 TPD₇. The existing Houston County landfill would be used as a backup landfill for plant residues and wastes that must bypass the plant.

The second alternative (alternative 2) is identical to the first with respect to location, waste supply, combustion technology, transportation, and backup landfill. However, it would produce higher pressure steam and use it to generate electricity with an extraction turbine,

while exhausting steam for sale at lower pressures. Electricity could also be produced during weekends, when RAFB's steam demand was less than the facility's steam output.

The third alternative (alternative 3) is to burn waste from Houston County only, in an MCU system that would deliver 125-psig steam into RAFB's steam lines. Average waste throughput would be 168 TPD₅. The plant could be erected on the base, as in the first two alternatives. A transfer/haul link from Perry and other southern county towns to RAFB is optional but not necessary.

B&W, Texprint, and YKK

B&W's continuous low-pressure steam demand, which is currently supplied by three coal-fired boilers, could be served by MCUs or an MBWW system, which could be located directly behind B&W's power plant or behind the adjacent Texprint plant. With B&W as its primary market, a resource recovery facility could increase its revenues by selling a portion of its steam output to Texprint and YKK, neighboring plants that now burn natural gas. Four alternatives were selected for consideration.

The first alternative for B&W (alternative 4) is to erect an MBWW facility near B&W to accept waste from Macon/Bibb County. This system would deliver low-pressure steam to B&W's steam distribution lines. The system could operate 5, 6, or 7 days per week; a 5-day-per-week operating cycle was selected for analysis. No transfer system would be necessary, because most of the Macon/Bibb County waste is generated in Macon. The Macon City landfill would serve as a backup landfill for plant residues and bypassed wastes.

The second alternative for this market (alternative 5) is identical to the first, except that steam lines would be constructed from the resource recovery facility to Texprint and YKK, to supply the steam needs of those firms. All of Texprint's and YKK's steam requirements would be supplied by either the resource recovery plant or B&W's coal-burning system.

Alternatives 6 and 7 correspond to alternatives 4 and 5, respectively, except that MCU technology would be used in place of the MBWW system. Again, while an MCU system could easily operate 6 or 7 days per week, a 5-day-per-week operating schedule was selected for purposes of analysis.

Armstrong Cork

Armstrong burns natural gas in long ovens to dry ceiling tiles. Part of the ovens could be converted to use a high-temperature gas produced by a clean-burning MCU system. In this alternative (alternative 8), an MCU facility would be erected within a few hundred feet of the western edge of the Armstrong plant. This facility would burn waste from Macon/Bibb County only and would produce high-temperature gas (heated air) via an air-to-air heat exchanger. If, in field trials, it was found that direct contact with exhaust gases from refuse combustion did not contaminate the tiles, the air-to-air heat exchanger could be eliminated and the exhaust gases vented directly into the ovens through injection ports. Direct venting would reduce system cost and increase energy efficiency.

For the purpose of analysis, an operating cycle of 5 days per week was selected for this alternative, but a 6- or 7-day-per-week cycle could be used by staggering scheduled outages. No transfer station would be necessary. As with alternatives 4 through 7, the Macon city landfill would be used as backup.

CHAPTER 4. EVALUATION OF ALTERNATIVES

The feasibility of the resource recovery alternatives available to Macon/Bibb and Houston counties depends on a variety of factors, such as economic feasibility, the degree of technological risk, and ease of implementation. The eight resource recovery alternatives identified in Chapter 3 were evaluated to determine their economic feasibility. As a result of this evaluation, a preliminary determination was made that four resource recovery projects are feasible for Macon/Bibb County and/or Houston County. The general advantages and disadvantages of the economically feasible projects were then examined.

ECONOMIC FEASIBILITY

To be considered economically feasible, a resource recovery project must offer Macon/Bibb County and/or Houston County a total solid waste disposal cost that is competitive with the cost of continued landfilling. Total solid waste disposal cost includes the capital and O&M costs associated with the resource recovery facility, the energy revenues for the project, and the capital and O&M costs of operating a backup landfill for disposal of residues and wastes that must bypass the facility.

To determine the economic feasibility of the various alternatives, the total disposal cost of each alternative was projected for 1983 and 1988, the first and sixth years of facility operation. The year 1983 was selected as the first year of facility operation, to reflect the lead time for design, construction, and startup of a resource recovery facility. Although life-cycle costing would have been an appropriate method of economic evaluation, the difficulty of projecting costs and revenues over the life of a facility (more than 20 years) limited the projections to 1988.

The projected disposal costs of the eight resource recovery alternatives were compared with the projected costs of continued landfilling. The results of this economic evaluation indicate that four of the eight resource recovery facilities are economically feasible:

1. Alternative 1, a 335-TPD₇ MBWW system using waste from Macon/Bibb and Houston counties to produce steam for RAFB.

2. Alternative 3, a 168-TPD₅ MCU system using waste from Houston County to produce steam for RAFB.
3. Alternative 7, a 295-TPD₅ MCU system using waste from Macon/Bibb County to produce steam for B&W, Texprint, and YKK.
4. Alternative 8, a 295-TPD₅ MCU system using waste from Macon/Bibb County to produce high-temperature gas for Armstrong Cork.

In conducting the economic analysis, it was found that the bond issue requirements, and, hence, the cost of a resource recovery system vary significantly, depending on the financing method used. To take these variations into account, cost projections for each resource recovery alternative were developed under three different financing methods: 100-percent industrial revenue bond (IRB) financing; 75-percent IRB and 25-percent equity financing; and 100-percent general obligation bond (GOB) financing. To date, IRBs and GOBs have been the principal instruments used for financing resource recovery projects. However, because of the tax benefits it affords to the investor, equity investment in a resource recovery project is becoming more common and was therefore included in the comparative economic analysis. (For a discussion of the advantages and disadvantages of each financing method, see Chapter 5.)

The results of the economic evaluation of the four feasible alternatives are presented in Figures 1 through 4. Each of these figures shows the projected cost of continued landfilling and the total disposal cost of the resource recovery alternative under each of the three financing methods, for the period 1983-1988. The total disposal costs for the four alternatives are detailed in Appendix C.

As the figures indicate, if any of these resource recovery projects began operation in 1983, it could become competitive with continued landfilling by 1988, if not sooner. For example, as shown in Figure 1, a 335-TPD₇ MBWW system producing low-pressure steam for sale to RAFB (alternative 1) would become economically competitive with landfilling by mid-1985, if it were financed with a combination of equity and IRB financing; but not until late 1987, if GOB financing were used. However, both

FIGURE 1

TOTAL DISPOSAL COSTS FOR MACON/BIBB AND HOUSTON COUNTIES:
ALTERNATIVE 1 -- 335-TPD₇ MBWW SYSTEM (\$thousand/year)

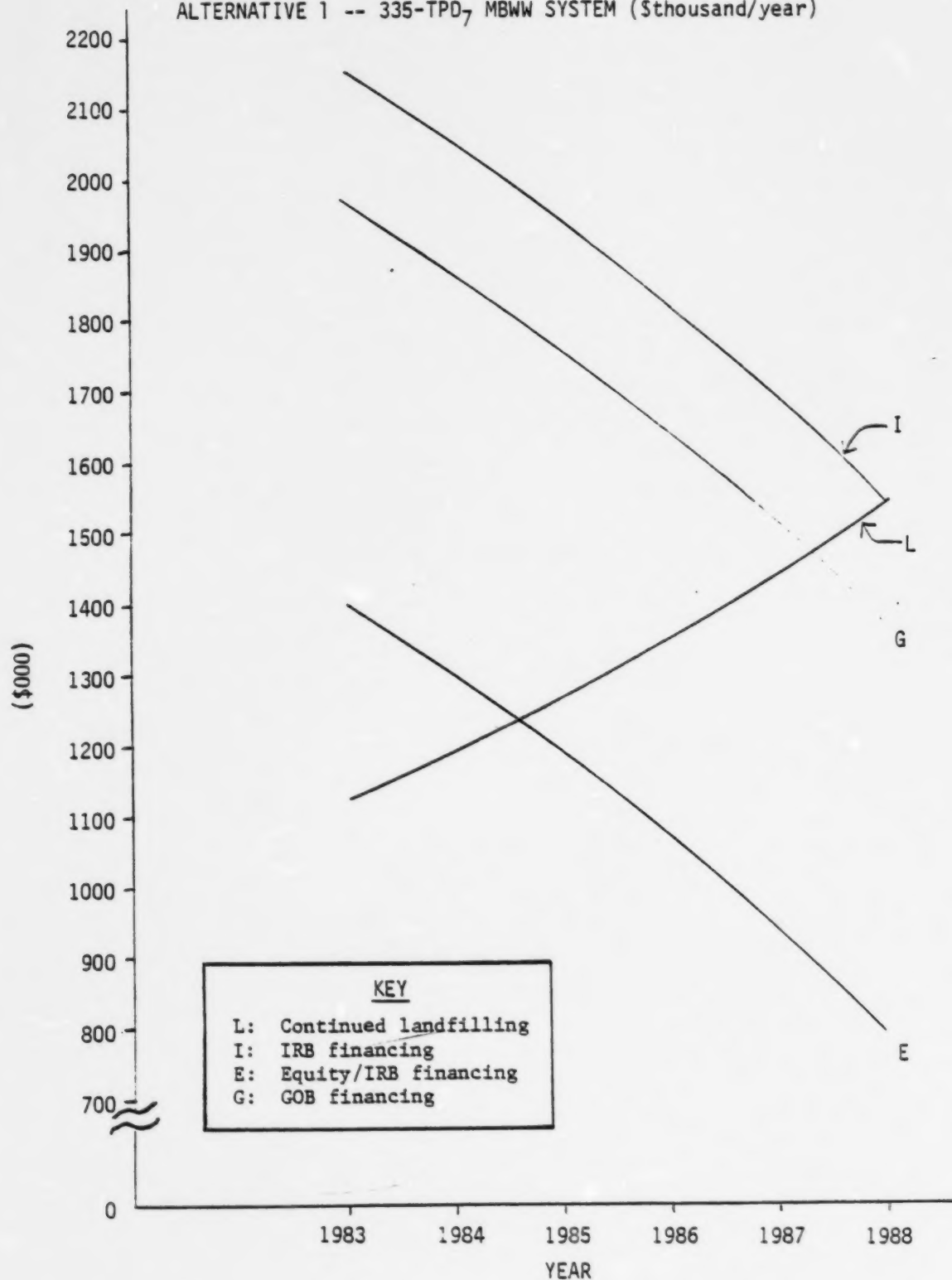


FIGURE 2

TOTAL DISPOSAL COSTS FOR HOUSTON COUNTY:
ALTERNATIVE 3 -- 168-TPD₅ MCU SYSTEM (\$thousand/year)

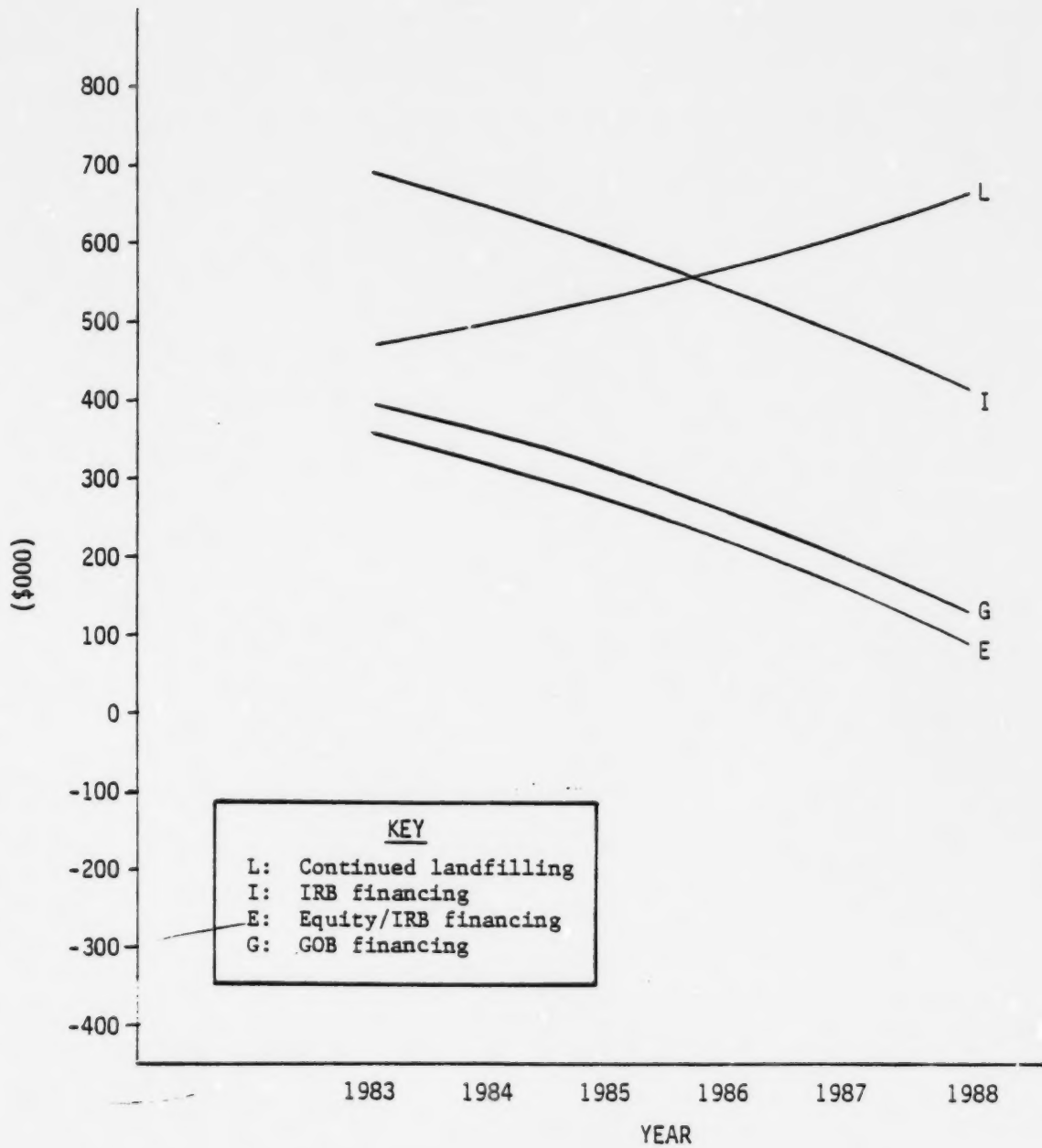


FIGURE 3
TOTAL DISPOSAL COSTS FOR MACON/BIBB COUNTY:
ALTERNATIVE 7 -- 295-TPD₅ MCU SYSTEM (\$thousand/year)

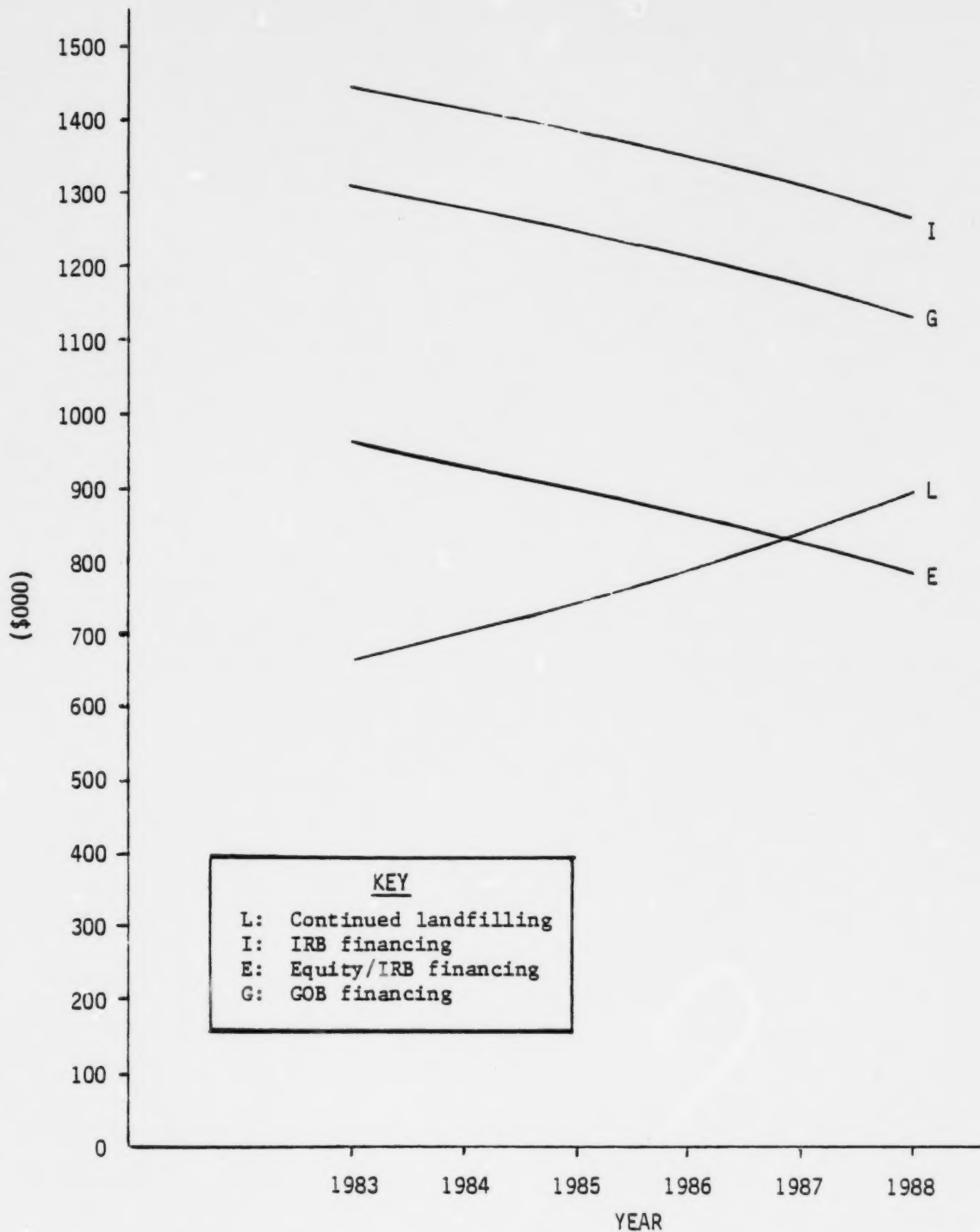
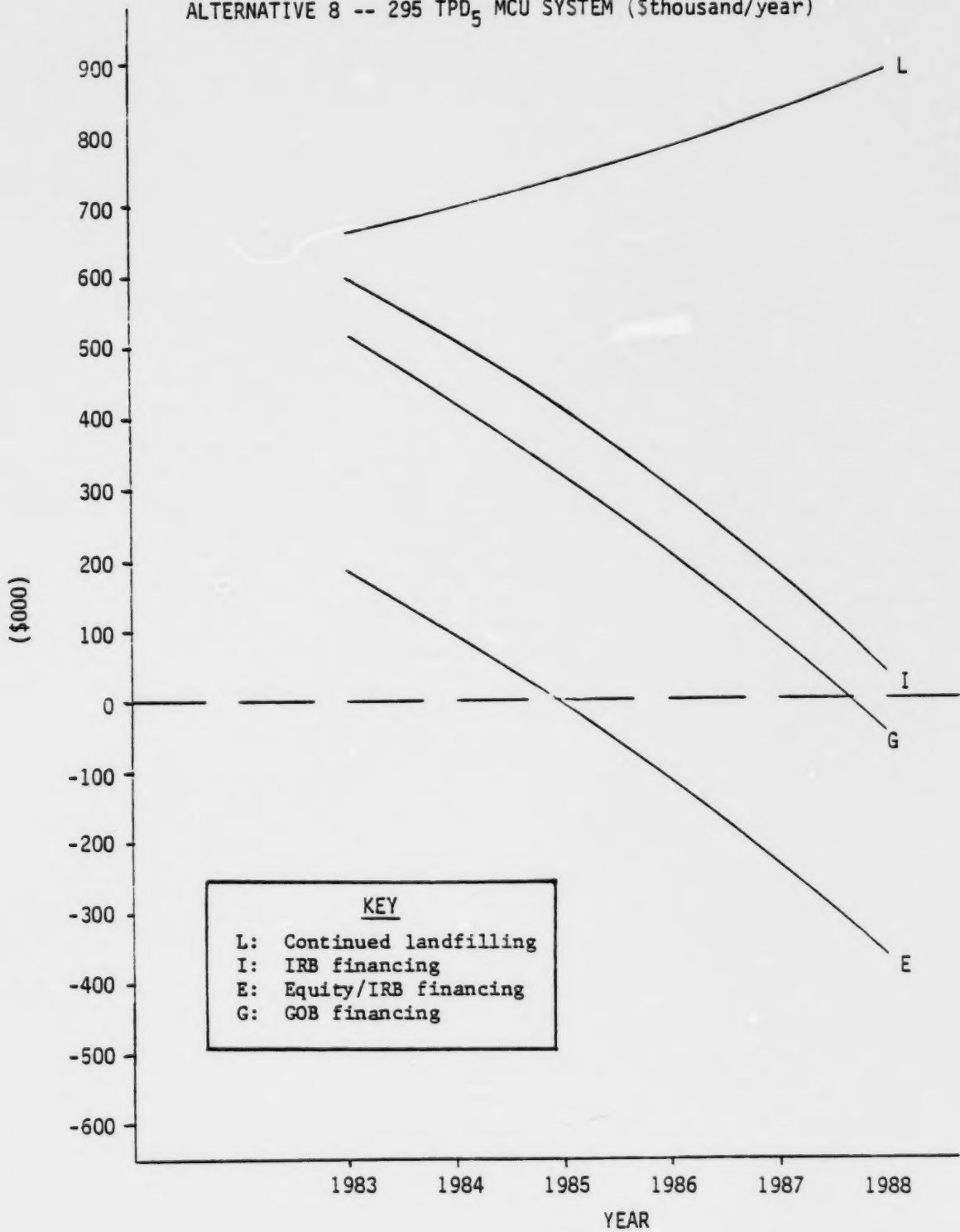


FIGURE 4

TOTAL DISPOSAL COSTS FOR MACON/BIBB COUNTY:
ALTERNATIVE 8 -- 295 TPD₅ MCU SYSTEM (\$thousand/year)



counties have more economically attractive options than the joint project at RAFB. For Houston County, the 168-TPD₅ MCU system at RAFB (alternative 3) is projected to become competitive with landfilling between 1984 and 1988, regardless of the financing method (see Figure 2). For Macon/Bibb County, the 295-TPD₅ MCU system serving B&W, Texprint, and YKK (alternative 7) could become competitive with landfilling by 1987, if it were financed with a combination of equity and IRB (see Figure 3). A more attractive opportunity for Macon/Bibb appears to be the 295-TPD₅ MCU system serving Armstrong Cork (alternative 8), which could be competitive with landfilling immediately upon starting operation (see Figure 4).

The assumptions used in developing the economic projections are detailed in Appendix D, along with derivations of system costs. The derivation of the major elements of the cost projections is summarized below.

Projected System Costs. The 1980 capital costs of MBWW and MCU systems were developed from engineering estimates and recent bids submitted by full-service vendors for resource recovery systems; these costs were then projected to 1982 (assumed to be the midpoint of construction) at an annual compound rate of 14 percent, for IRB, equity/IRB, and GOB financing approaches. For 100-percent IRB financing, energy and disposal fee revenues are the only source of payment for bond holders, who receive tax-exempt interest at a rate assumed to be 10 percent. For equity/IRB financing, the 25-percent equity contribution enables reductions in the debt service reserve and capitalized interest accounts and reduces the total bond issue by approximately \$1.30 for each dollar of equity invested. For GOB financing, the full faith and credit of the project sponsor, in addition to energy and disposal revenues, are pledged to payment of the bond holders. Consequently, the risk to bond holders is significantly reduced, and a corresponding reduction in the interest rate (to 8.5 percent) was assumed in projecting system costs.

Revenue Projections. In projecting the energy revenues for

each alternative, the following assumptions were made:

- The price of the facility's energy output reflects, on a Btu-equivalent basis, the price of the fuel displaced, less a 15-percent discount to the energy customer.
- Coal price escalates at a compound annual rate of 10 percent from 1980 through 1988.
- Natural gas price is deregulated and achieves parity with 1-percent-sulfur No. 6 oil by 1983. The price of No. 6 oil (70¢ per gallon in February 1980) escalates at a compound annual rate of 10 percent from 1980 through 1988.*

Backup Landfill Costs. For each alternative, the backup landfill must accommodate unprocessibles (20 percent of waste generation) and residues (10 percent of system throughput). It was assumed that a combination front-end loader and compactor, smaller than the equipment used for a raw-waste landfill, could be used in the backup landfill, which could operate with a staff of two, rather than three. Other landfill cost assumptions are outlined in Appendix A. For alternatives 1 and 3, in Houston County, the cost of a backup landfill is projected to be \$186,400 in 1983 and \$272,000 in 1988. For alternatives 7 and 8, in Macon, the cost of a backup landfill is projected to be \$239,500 in 1983 and \$336,100 in 1988. (A breakdown of these cost projections is presented in Appendix D.)

COMPARISON OF FEASIBLE PROJECTS

To complete the evaluation of the resource recovery alternatives, those alternatives identified as economically feasible were examined, and their noneconomic advantages and disadvantages identified. In this section, the advantages and disadvantages of each economically feasible resource recovery alternative are discussed and compared.

Alternative 1. This 335-TPD₇ MBWW system would use waste from Macon/Bibb and Houston counties to produce steam for RAFB. The chief

* On the basis of information available, it appears as though natural gas prices will be deregulated. In the event that deregulation does not occur, the projected energy revenues obtained from the displacement of natural gas would probably be lower.

advantage of this alternative is that it would provide for disposal of all the processible waste from both counties with a single resource recovery project. Another obvious advantage is RAFB's continued, active interest in the concept of recovered energy and the willingness of RAFB to make an appropriate site available.

The chief disadvantage of this alternative is its projected total disposal cost, which, while economically competitive with the projected cost of continued landfilling, is higher than those of the other economically feasible alternatives. This higher cost estimate results from the use of capital-intensive MBWW technology, the costs of transferring waste from Macon/Bibb County to RAFB, and RAFB's low weekend and summer steam demand, which would be less than the facility's steam output. Another disadvantage is that RAFB cannot commit to making any equity contribution to the project without receiving final authorization for capital expenditures from the U.S. Congress.

Alternative 3. This 168-TPD₅ MCU system would use waste from Houston County alone to produce steam for RAFB. This alternative appears to be the most economically attractive opportunity for Houston County. As with alternative 1, RAFB's demonstrated commitment to the concept and willingness to make a site available are major advantages. The only apparent disadvantage to this alternative is that RAFB cannot guarantee an equity contribution that would reduce the capital financing requirements.

Alternative 7. This 295-TPD₅ MCU system would use waste from Macon/Bibb County to produce steam for B&W, Texprint, and YKK. On the basis of the financing alternatives considered, this option appears to be economically feasible only if 25-percent equity financing can be obtained. B&W, the primary customer in this market, has indicated a willingness to consider equity participation, and appropriate sites appear to be available for the facility. The major drawback to this alternative is that its economic feasibility depends upon the availability of partial equity financing. In addition, approximately 45 percent of the resource recovery system's output must be priced to reflect the displacement of higher priced natural gas at Texprint and YKK (B&W currently burns coal).

The maintenance of two different pricing schemes for the waste-derived steam is likely to impose an administrative burden on the project.

Alternative 8. This 295-TPD₅ MCU system would use Macon/Bibb County waste to produce high-temperature gas for Armstrong Cork. Like alternative 7, this option appears to be economically attractive in comparison to the costs of continued landfilling. There appears to be an appropriate site near the Armstrong ovens and adjacent to a major highway. In addition, after further study and tests, it may prove feasible to vent high-temperature gas directly from the system to the ovens, rather than using the air-to-air heat exchanger. Direct venting is more energy-efficient and would improve substantially the economics of the project.

The production of waste-derived hot gases in an MCU-based system with an air-to-air heat exchanger has been successfully demonstrated in a variety of industrial applications using industrial wastes (e.g., at the John Deere plant in Wisconsin). While use of an MCU-based system burning municipal waste to produce hot gases for sale has not been demonstrated, because the waste gases from municipal and industrial waste combustion are similar, no unusual problems are anticipated with this resource recovery option.

CHAPTER 5. STEPS TOWARD IMPLEMENTATION

The results of this preliminary feasibility study of resource recovery for Macon/Bibb and Houston counties indicate that the necessary ingredients exist for at least one resource recovery project in each county. However, the technical evaluation and economic analysis of resource recovery alternatives are preliminary, and a number of tasks must be performed and issues resolved before any commitment to implement one or more of the systems is made. Specifically, before committing substantial additional resources to a project, the two counties must determine more precisely: the level of interest of potential energy markets; the quantity of processible waste available, its energy content, and seasonal fluctuations in quantity and quality; and current control of the waste streams. After these determinations have been made, the counties will be able to make informed decisions about implementing specific projects. If the counties decide to implement one or more projects, it will be necessary to resolve a number of issues (e.g., sponsorship, risk allocation, procurement financing, optimal system design, legal and institutional problems) before moving ahead with implementation.

In this chapter, the immediate next steps to be taken are outlined, and the remaining issues are discussed.

IMMEDIATE NEXT STEPS

Before a final decision is made to implement a resource recovery project, three tasks must be performed. Each is discussed in the following subsections.

Determine Level of Commitment of Energy Customers

The preliminary market study indicates that five prospective customers are interested in purchasing energy from a resource recovery project; however, this interest is preliminary. For that reason, the level of commitment of potential energy customers must be established to ensure that there will

be an energy buyer if the project proceeds. Before deciding to commit themselves to implementation of any project, the two counties must meet with the prospective customers to discuss in detail the customer's energy requirements, their willingness to commit to long-term contracts for the purchase of recovered energy, and their interest in equity participation in a project.

Determine Quantity and Energy Content of Available Waste

The quantity of waste available in Houston County has been determined, and a preliminary characterization of solid waste composition in the two counties has been performed; however, considerable additional work is needed in this area. Specifically, a weighing program should be established at the Macon city landfill to determine the quantity of solid waste generated in the city of Macon/Bibb County. In addition, waste sampling programs should be conducted in both counties to estimate what portion of total waste generation is processible and the energy content (i.e., HHV) of the processible waste. Finally, the seasonal fluctuations in waste quantity and quality should be established.

Develop Strategies for Waste Control

Although solid waste collection and disposal practices in the two counties have been reviewed, a more detailed analysis of collection and disposal is needed. From this analysis, it should be possible to determine the extent to which the two counties have the right to decide where waste is to be disposed and, thus, to assess the risk that a resource recovery project would not receive all of the waste expected. The counties can then develop appropriate waste control strategies, to ensure that processible waste will be directed to the resource recovery facility.

IMPLEMENTATION ISSUES

If the results of the steps detailed above confirm the preliminary feasibility of resource recovery and a decision is made to implement one or more projects, a number of issues will need to be addressed prior to implementation. Many of these issues are interrelated and cannot be considered totally independently. Therefore, to resolve these issues,

it will be necessary to address several of them simultaneously, rather than consecutively. The issues include:

- Who will sponsor the project?
- How should project risks be allocated?
- What procurement method should be used?
- What financing method is most appropriate?
- What is the optimal system design?
- What are the legal and institutional barriers to implementation, and how can they be overcome?

In the following subsections, each of these issues is examined, to highlight the major factors to be considered in resolving it.

Project Sponsorship

A decision must be made as to what entity should sponsor the project. For a joint project serving Macon/Bibb and Houston counties, possible sponsors include: a special solid waste management authority, created specifically for the project; the two counties and major cities in the area, in a joint venture; and one of the counties or cities that is interested in assuming the lead role and to which responsibility can be delegated (e.g., the city of Warner Robins, Houston County). For a project serving Houston County alone, possible sponsors include Warner Robins, Houston County directly, the Houston County Development Authority, and a Houston County Solid Waste Management/Resource Recovery Authority, which could be created for the project. For a project serving Macon/Bibb County alone, possible sponsors include: a special authority created for the project; the principal participants (e.g., the city of Macon, Bibb County) in a joint venture; and a single entity that can assume sponsorship responsibility (e.g., the city of Macon, Bibb County, the Macon-Bibb County Industrial Development Authority).

The creation of a special authority has certain advantages over sponsorship by an existing entity. In most states, a specially created solid waste management authority is not subject to competitive bid

requirements of construction and, thus, can adopt the most appropriate procurement method, select the most qualified system vendor through negotiated bidding, and negotiate long-term contracts for solid waste delivery and system operation. The major limitation of sponsorship by a specially created entity is its lack of taxing authority, which limits financing options to IRBs or equity and IRBs.

Allocation of Project Risks

Unlike public works projects normally undertaken by local governments, resource recovery projects are risky, chiefly because:

- Recovery technology is not fully proven.
- Waste volumes and composition are variable.
- Operating experience is limited.
- Product user requirements are stringent.

These factors give rise to specific risks in four areas:

1. Project economics (e.g., lifetime operating and maintenance costs, lifetime product revenues, capital costs, lifetime net disposal costs).
2. Marketing (e.g., user requirements, user investments, product prices, contract duration).
3. System performance (e.g., product quality, recovery efficiency, processing capacity, reliability, residual disposal requirements).
4. Waste stream (e.g., volume changes, composition changes, payment of disposal fees).

The sponsoring entity must evaluate each area of risk and determine which participant in the project is best able to assume and manage a particular risk. For example, the project sponsor can deal with the risk that a minimum daily tonnage will fail to be delivered to the project. By contrast, the system vendor/operator can best deal with the risk that the system will not be able to process the amount of waste it was designed to handle.

In general, the system vendor can best deal with the economic and technical risks associated with the project's technology. The project sponsor will need to devise mechanisms to ensure that the system vendor

assumes these risks. System vendors are often asked to provide contractual guarantees of system performance and economics (e.g., processing capacity, recovery efficiency, plant reliability and availability, product quality, O&M costs). In return, the vendor receives a service fee that compensates for the risks assumed.

Procurement Approach

There are three methods of procurement used for resource recovery projects:

- An architectural and engineering (A&E) contract, which is customary for facility design and equipment selection, preparation of competitive bid specifications, construction supervision, and, possibly, facility shakedown. Construction and equipment installation are competitively bid. Full-scale operation and, possibly, shakedown are the responsibility of the public owner.
- A turnkey approach, in which a single entity performs the services that would otherwise be provided by an A&E, plus construction, testing, and shakedown of the system. Payment is made to the turnkey contractor following successful shakedown and acceptance by the public sponsor. Full-scale operation is the responsibility of the public owner.
- A full-service approach, in which a single contractor performs all functions of a turnkey contractor and is responsible for full-scale operation of the facility (generally ranging from 5 to 20 years).

The following table summarizes the extent to which various project risks can be transferred from the public sector to private industry under the three procurement approaches:

<u>Key Project Risks</u>	<u>A&E</u>	<u>Turnkey</u>	<u>Full Service</u>
Project economics	None	Limited	Substantial
Marketing	None	None	Substantial
System performance	{ Very Limited	Limited	Substantial
Waste stream	None	None	Limited

The full-service approach vests the maximum degree of control in the vendor and, thus, offers the greatest opportunity for transferring risks to the vendor. The sponsoring entity can transfer a maximum of risk to the full-service vendor/operator by obtaining contractual guarantees for the system's technical and economic performance.

Financing Method

Resource recovery projects in the United States have typically been financed with tax-exempt GOBs or IRBs, but, as a result of recent changes in tax laws, resource recovery system vendors, developers, financing entities, and industrial concerns (i.e., energy customers) are increasingly interested in assuming constructive ownership of a resource recovery facility. Constructive ownership affords substantial tax benefits (i.e., investment tax credits, depreciation tax shield). Internal Revenue Service (IRS) requirements for constructive ownership can be satisfied by making an equity contribution to the project or by assuming responsibility for its total debt service obligations.

In making the preliminary determination of the feasibility of resource recovery projects for Macon/Bibb and Houston counties, economic feasibility was examined under three financing methods: 100-percent IRB, 25-percent equity and 75-percent IRBs, and 100-percent GOB (see Chapter 4). As was illustrated in Figures 1 through 4, the choice of financing method has a major impact on the economic attractiveness of a given resource recovery project. However, in addition to economic impacts, each financing method offers several benefits that must be considered in selecting an appropriate financing method, as outlined in the following paragraphs.

IRB Financing. Tax-exempt IRBs are commonly used to finance resource recovery projects. Because project revenues (i.e., energy revenues and disposal fees) are the only sources of funds to retire IRBs, a rigorous analysis of project economics is required, to ensure that revenues will be sufficient. Hence, the effect of IRB financing is to ensure that any project implemented is fully justified on its economic

merits. In addition, IRBs do not reflect on the debt capacity of the issuing entity, because the funds are borrowed on a project basis.

Equity/IRB Financing. Under this financing method, a partial equity contribution is made by a private investor (e.g., the energy customer, the system vendor, the project developer), and the balance of funding is obtained through IRBs. The equity contribution reduces the bond issue requirement and provides significant tax advantages to the private investor. Depending on the investor's tax bracket, the timing of the investment tax credit, and the depreciation period and method used, the net present value of the tax benefits resulting from a 25-percent equity contribution can represent an after-tax return on investment of 25 to 30 percent. However, to realize such a return, the equity contribution must be made by an entity that can utilize the tax benefits, i.e., a profitable concern with taxable income to shelter. In addition, the equity contribution vests project ownership with the private investor and, for practical purposes, requires private operation of the facility.

GOB Financing. Like IRBs, tax-exempt GOBs are commonly used to finance resource recovery projects. In addition to project revenues, the full faith and credit of the sponsoring entity are pledged to retirement of GOBs, so taxing mechanisms may be used to meet obligations in the event that project revenues are insufficient. As a result, GOBs are less risky for bond holders than are IRBs, carry a lower interest rate and bond financing costs, and are easier to market. (Bond financing costs are typically less than 0.5 percent of total bond issue for GOBs but may be as high as 3 percent for IRBs.) However, because of the full faith and credit pledge, GOBs can typically be used only for projects sponsored by entities having taxation authority. In addition, GOBs do reflect on the debt capacity of the issuer. Consequently, debt capacity ceilings may be reached, precluding subsequent debt issues for financing such projects as hospitals or schools.

System Design

For the purpose of this preliminary feasibility study, the scale and technology for each resource recovery alternative were selected to

fit the estimated energy requirements and practices of the prospective energy customer. However, no attempt was made to optimize a given resource recovery system. Additional analysis must be performed to establish more specifically the scale and configuration of any resource recovery technology to be implemented. For example, if a decision were made to implement alternative 1 (the 335-TPD MBWW system for RAFB), the technology as well as the scale to be used must be selected, because a dedicated boiler is assumed to have costs and operating parameters that are similar to those of the MBWW technology.

The optimal scale for any given project will depend on the results of the analysis of waste generation, composition, and control (i.e., current waste generation, the supply of processible waste, and the amount of waste available for delivery to a resource recovery project). In addition, the counties need to consider the possible increase in solid waste generation, which depends on population growth in the period 1980-2000. In 1979, a 33-percent population increase over this period was projected for Houston County, and a 20-percent increase for Macon/Bibb County.¹ After considering current and projected waste supply, the two counties will need to decide whether to build: a system that will be too large initially but will accommodate an increasing amount of waste; a system that will be too large initially, appropriately sized for the middle of its useful life, and too small in later years; or a system that will be appropriate for the waste supply in its initial years, with some allowance for future expansion as waste generation increases.

Further analysis may be necessary to identify optimal system configuration. For instance, for the MCU systems, fewer but larger combustion units may be appropriate. For the MBWW system, to minimize capital costs, it has been assumed that the system would consist of a single combustion unit with a waste heat boiler. However, it may prove more appropriate to design a two-unit system or a one-unit system with an allowance for adding a second unit to accommodate an increased tonnage of waste. A one-unit system is equally reliable and will process the same amount

1. Macon-Bibb County Planning and Zoning Commission, Macon/Bibb County/ Middle Georgia Resource Recovery Study, June 1979; Middle Georgia Area Planning and Development Commission, Houston County/Middle Georgia Resource Recovery Study, August 1979.

of waste per year as a two-unit system. However, in the event of an outage of one unit, only one-half of the waste delivered to a two-unit resource recovery system would have to be bypassed; with a one-unit system, all waste would be bypassed during an outage. To determine the optimal MBWW system configuration, tradeoff analysis may be in order.

Legal and Institutional Barriers

There are numerous legal and institutional barriers to the implementation of a resource recovery project, primarily because few projects have been implemented. Institutional and legal barriers include site acquisition problems; traffic impacts on the surrounding neighborhoods and communities; the legality of negotiated procurements, long-term put-or-pay contracts with waste haulers, and take-or-pay contracts with energy users; and the prospect of mandatory participation of private haulers. All of these barriers must be overcome before project implementation.